

STATE OF CALIFORNIA  
DIVISION OF HIGHWAYS  
MATERIALS AND RESEARCH DEPARTMENT

-oOo-

A REPORT  
On The  
CONSTRUCTION OF AN EXPERIMENTAL SEAL COAT PROJECT  
On A  
PORTION OF THE HIGHWAY IN SANTA BARBARA COUNTY  
Designated As  
V-S.B-2-M U. S. 101  
Work Order No. 95K4  
Between Stations 88+91 and 143+13

47-01

---

By  
George Sherman  
Assistant Physical Testing Engineer  
December 26, 1947

47-01

STATE OF CALIFORNIA  
DIVISION OF HIGHWAYS  
MATERIALS AND RESEARCH DEPARTMENT

-oOo-

A REPORT  
on the  
CONSTRUCTION OF AN EXPERIMENTAL SEAL COAT PROJECT  
on a  
PORTION OF THE HIGHWAY IN SANTA BARBARA COUNTY  
Designated as  
V-S.B-2-M U.S. 101  
Work Order No. 95K4  
Between Stations 88+91 and 143+13

The construction of an experimental section to compare the qualities of screenings on seal coat construction was first discussed early in 1947 as a further extension of an investigation carried out during 1946 and reported in a memorandum to Mr. G. T. McCoy dated September 5, 1946. The proposed experimental construction was discussed in a letter dated May 28, 1947, by Mr. T. H. Dennis. The final arrangements were covered in a memorandum Dennis to Stanton dated August 5, 1947. The actual work was carried out on August 19 and 20, 1947, between Stations 88+91 and 143+13 on road V-S.B-2-M. The work was done by State Maintenance forces under Maintenance Superintendent Sutcliffe under Work Order No. 95K4.

The experiment was made to compare the quality of screenings manufactured by the Walter Roselip Company at Atascadero, the S. P. Milling Company at Sisquoc, and the Granite Rock Company

at Logan. Every effort was made to give each of the three products the same treatment.

The site selected for sealing consisted of a PCC road which had been blanketed with plant-mixed surfacing and sealed with an emulsion fog seal. This particular section of road was chosen because it presented a generally uniform, non-absorptive surface that had not been covered previously with screenings.

### CONSTRUCTION

It was originally planned to apply liquid asphalt Grade RORC-5 at the rate of 0.20 gallons per square yard. 3/8" x #6 screenings were to be spread at a rate of 22 pounds per square yard for Roselip, 22 pounds per square yard for S. P. Milling, and 25 pounds per square yard for Granite. These quantities of screenings allowed for a differential in specific gravity of 2.50 for Roselip and S. P. Milling, and 2.85 for the Granite product.

During the week previous to the placing of the experimental seal coat, Mr. Mendenhall, Maintenance Superintendent at Santa Maria, placed a seal coat on Route 2 just south of Santa Maria. He used an oil application of .21 gallons per square yard with S. P. Milling screenings. The job appeared overoiled and bled sufficiently to require sanding.

Because of Mr. Mendenhall's experience, it was decided to maintain the oil application on the experimental project within a range of 0.15 to 0.17 gallons per square yard with the screening applications to remain the same as planned. It was expected that these quantities would give an excess of screenings but would also insure the maximum amount of screenings sticking to the pavement.

The equipment furnished by the District consisted of a new Etnyre distributor with a capacity of 2675 gallons. The full circulating boot was equipped with 18 nozzles at 4" center and had two extensions of 9 nozzles each at 4" center. This distributor was rented for the job by the Maintenance Department. It is owned by Mr. Charles Harrington of Santa Maria.

Screenings were spread by means of a State-owned screw type chip spreader.

The project was completed in two days. On the first day approximately 2010 feet of S. P. Milling, 1725 feet of Granite, and 1700 feet of Roselip screenings were placed on the west lane in the order mentioned. On the second day approximately 1625 feet of Roselip, 1301 feet of Granite, and 2503 feet of S. P. Milling screenings were placed on the east lane as indicated on Figure #1.

When tests on the liquid asphalt were performed, it was found that the viscosity on the samples taken from the second day's run was 190 seconds lower than the samples taken from the first day's run, and the second sample did not comply with the specification requirements. It appears that this discrepancy was caused by blending with the material that was far outside the specification grade, as it happened that at the completion of the first day's run the distributor truck still had approximately 850 gallons of RORC-5 remaining in the tank. On the following day the additional 390 gallons of asphalt were added at the Refinery, but this latter quantity was evidently not drawn from the tank which had been tested by the State inspector

on August 18. The original tank tests indicate that the material conformed with specifications, and this finding was confirmed by samples taken from the truck on the first day. It seems inescapable that a non-specification material was added to the truck for the second day's operations.

Before starting the job, a trial run was made with the spreader box. The speed of the truck and adjustments on the spreader box were determined in order to give a spread of 22 pounds per square yard. The weight was determined by weighing the quantity found to cover a square yard on the road. This attempt to control the spread proved to be ineffective as the spreader box, even though the screw feed was geared to its wheels, did not deliver a uniform amount of screenings. A square yard plywood tray placed under the spreader box at intervals to catch samples of the typical spread showed large variations in the amounts of screenings actually delivered to the road. The largest variations appeared to be due to the speed with which the various trucks pushed the spreader box. The following tabulation of the screenings spread by the various trucks seems to indicate that the driver of truck #70 was more efficient at maintaining a uniform speed than were the drivers of the two State trucks. The figures under each truck number indicate the average spread for each load delivered.

Screenings Spread #/s.y.						
	:	Truck # 70	:	CHC 9252	:	CHC 7578
S.P. Milling Co.	:	17	:	35	:	37
	:	22	:	29	:	38
	:	20	:	22	:	
	:		:	34	:	
	:		:	20	:	
	:		:	19	:	
	:		:	20	:	
	:		:	24	:	
Granite Rock Co.	:	24	:	36	:	45
	:	35	:	18	:	24
	:	24	:	19	:	
	:	21	:		:	
W. Roselip Co.	:	23	:	29	:	24
	:		:	27	:	
	:	24	:	25	:	
	:	20	:		:	
	:		:		:	

In an attempt to obtain a more uniform spread the three trucks were sent to Santa Maria and weighed level full. The volumes of the trucks were calculated and the distance each truck should travel to deposit a level full load on the road was computed. These calculations helped to smooth out the spread.

The oil distributor caused considerable difficulties on the job. It was calculated from tables for the distributor that a gauge setting indicating 100 gallons per minute at a speed of 675 feet per minute would give a spread of 0.15 gallons per square yard. However, the distributor operator allowed the pressure to rise to 150 gallons per minute and actually placed 0.20 gallons per square yard on the first spread of oil. Other troubles encountered with the distributor were failure to lower the boot to spraying position for one spread and inability of the driver to steer a straight line making it necessary to spread an extra strip of screenings on the second day's operations. A good deal of trouble developed due to the plugging of the nozzles. The second day the entire extension

bar of 9 nozzles gave a weak spray even though the spray nozzles were first cleaned and later replaced with new nozzles.

Referring to Figure #1 it will be noted that each spread of oil made by the distributor is numbered in the order in which the spread was made with spreads (1) and (6) being placed on August 19 and spreads (7) to (12) being placed on August 20.

#### SAMPLES OBTAINED

48 hours after placing one square yard of screenings were removed from each spread at a location one to four feet from the outer edge of the pavement. At one location two samples were obtained with the second sample taken one to four feet from the centerline of the road. In all, thirteen square yard samples of screenings were obtained representing 12 individual truck loads.

In addition to the above 13 samples, four sacks of each type of screenings were obtained from stockpiles on the job and shipped to Sacramento for testing. As the screenings were spread samples were taken from under the spreader box at various points by means of the special square yard tray shown in the photograph Figure #7. These samples represent an attempt to measure the rate of spread and also to evaluate the uniformity of the grading of the stockpiled screenings.

#### TEST RESULTS

Table I shows the grading obtained on stockpiled materials compared to the grading of the materials delivered to the road. A study of Table I indicates that W. Roselip Company furnished the most uniformly graded product. All of the samples of the

three products comply with the Standard Specifications with the exception of one sample of Granite Rock screenings test No. 54443 which is 1% high on the passing No. 4 sieve. (Table I).

The Roselip product is fairly round uncrushed gravel. The S. P. Milling Company screenings are crushed from a gravel similar in type and shape to the Roselip product, while the Granite Rock Company screenings are crushed rock with a greater percentage of flatter and more elongated shapes. It is probable that when screened through square opening screens the rounded uncrushed screenings form a more uniform product than does the crushed product of Granite Rock.

The bituminous binder in the thirteen samples of the screenings taken from the road was extracted in the laboratory and the grading and total weight of the individual samples was determined. These samples were removed from the road surface by means of a scraping knife as shown in the photograph Figure #8.

Table II compares the weight of screenings spread to the weight retained on the road. The amount of screenings spread represents average figures obtained from the area covered by one truck load. As indicated by previous studies there is no apparent relation between the amount of screenings applied and the amount retained. However, since the amount of screenings applied is an average figure and it was evident during construction that the spread was not always uniform, it is possible that the figures shown in the table are misleading. Averages for the entire job show that 65.4% of S. P. Milling's screenings were retained, 65.8% of Granite Rock's and 58.8% of W. Roselip's. In judging

these results it should be remembered that the samples were obtained from what appeared to be the best section of each spread.

Samples 54361 and 54364 from the same transverse line on the road represent the uniformity with which the screenings were spread by the spreader box. Sample 54361 was obtained one to 4 feet from the shoulder and sample 54364 was obtained one to 4 feet from the centerline. The area nearest the shoulder, sample 54361, had a dry streak through it caused by a plugged spray nozzle and it was expected that this sample would show less weight of screenings per square yard than the sample obtained near the centerline of the road. The reverse was true, however, with sample 54361 having 17 pounds per square yard recovered, and sample 54364 having only 15 pounds per square yard. This indicates variation of 2 pounds per square yard in the width of the spread.

Table II also shows the grading analysis of the screenings after rolling. It is immediately apparent that the screenings have degraded or crushed under the roller to a point where they no longer comply with the Standard Specifications grading requirements for medium screenings. The final product on the road, then, is a more densely graded aggregate and this factor must be taken into consideration when attempting to calculate the most economical amount of screenings to spread for a given application of oil.

Figure #2 shows graphically the average gradings of the screenings before placing and after rolling. It will be noted that the Roselip and S. P. Milling products have approximately

the same grading after rolling while the Granite screenings are somewhat finer. Reduced to surface area\* figures, the curves show the following average results.

Manufacturer	Surface Area Sq. Ft. Per Lb.		
	Before Rolling	After Rolling	% Increase
S. P. Milling	5.2	15.7	320
Granite Rock	4.6	20.8	450
W. Roselip	2.7	18.2	670

The above table indicates that Roselip screenings of the grading furnished for use on this project undergo a greater change in grading and, therefore, show a greater increase in surface area under rolling than is the case for the other two materials. The Roselip material contained less fines as placed on the road, but the final gradings are quite similar for all three materials. As further evidence on the question of breakdown, the charts Figures 3, 4, and 5 were prepared. Figure 3 shows two previous jobs from which the Laboratory recovered samples of the Roselip medium screenings and where records were available of the gradings of the screenings before placing. The screenings used on both the present job, Work Order 95K4, and on Contract 45VC2 in 1942, road V-SLO-2-B,C, had approximately the same initial grading and are shown on the chart by one curve. The initial grading for Contract 25VC7 is not known. The grading after 48 hours on the road from Work Order 95K4 and the curve after 4 years for Contract 25VC7 are, for all practical purposes, identical. Contract 45VC2, on the other hand, shows

\*It has been well established that the rate of breakdown or crushing of stone particles follows Rittinger's Law which states that the amount of work required is directly proportional to the new surface area created.

greater degradation in 4 years than does Contract 25VC7. This may have been caused by a difference in the amount of rolling given the screenings for each job.

Figure 4 shows the degradation of S. P. Milling screenings on Contract 05VC6, road V-S.B-2-D, as compared to the 48 hour results obtained from Work Order 95K4. The average initial grading on both projects was the same. However, it is understood that when Contract 05VC6 was placed in 1941 that S. P. Milling Company produced uncrushed screenings. One month after Contract 05VC6 was completed, the District submitted to the Laboratory for extraction and grading, four samples of screenings removed from the road. Five years later, in 1946, Mr. Lovering of this Department and Mr. Cooper of the Maintenance Department obtained two more samples. The average gradings of both sets of samples are shown on the chart. Judging from these results it would appear that S. P. Milling Company screenings show very little degradation due to traffic or weathering with practically all of the breakdown occurring under the roller. The differences in grading between Contract 05VC6 and Work Order 95K4 could be due to differences in roller weights, amount of rolling, crushing, or actual differences in the quality of the screenings. Future samples obtained from Work Order 95K4 should clarify the question concerning the comparative quality of the materials. At the present time, laboratory tests do not indicate a difference in quality between the crushed and uncrushed screenings from the S. P. Milling Company.

Figure 5 shows the effect of traffic and rolling on Granite Rock Company's screenings. No evidence was available from previous contracts where the original and recovered gradings were available. Samples obtained by Mr. Lowering and Mr. Cooper from Contract 25TC2, road V-Mon-2-DE, six years after placing in 1940, show approximately the same grading for Granite Rock as the 48 hour samples from work Order 95E4. Thus, it is a reasonable assumption that Granite Rock screenings do not degrade under traffic.

In addition to the above tests, the Aggregate Department has tested the screenings for weathering in the modified Deval abrasion test. Samples of screenings before and after rolling were tested and showed the following weighted average losses after five cycles of wetting, drying, and abrasion.

<u>Manufacturer</u>	<u>Weighted Average Loss</u>	
	<u>Before Rolling</u>	<u>After Rolling</u>
S. P. Milling Co.	6.8	5.8
Granite Rock Co.	5.4	5.0
W. Roselip Co.	12.0	5.8

From an examination of the above results it appears that the Roselip screenings are altered and broken down to a greater degree by rolling. Also, that once the rolling operation is completed the three products are about equal in their ability to resist further degradation.

In addition to the modified Deval wetting and drying test, the standard wet shot rattler test was made on the three products using a modified grading consisting of 2500 grams of 3/8 to No. 3 and 2500 grams of No. 3 to No. 4 material. The test results

showed a loss of 20.8% for S. P. Milling's screenings, 24% for Granite Rock, and 39.4% for Roselip.

Figure 6 shows the relationship between the losses in the wet shot test and the crushing action of a steel tired roller. The abscissa values on the curve are expressed as per cent gain in surface area and were obtained from the average gradings of the stockpiled materials and the average gradings of samples recovered from the road after rolling. For the three materials tested the curve shows a good correlation between the wet shot test and the breakdown actually occurring on the road.

#### CONCLUSIONS

1. From the data obtained so far it appears that when compared to the Granite and S. P. Milling products, the Roselip medium screenings have less resistance to degradation under a roller. It is pointed out, however, that the Roselip screenings contained less fines than the other two. Just how much any differences in original grading may have influenced the results is not known. Other evidence, however, such as the laboratory tests, indicate greater tendency of the Roselip material to break down, regardless of grading.

2. The test results obtained on this and other projects indicate that practically all degradation of screenings occurs when the screenings are rolled under a steel tired roller with practically no further change in grading over a period of years.

In order to reach well supported final conclusions on the process of breakdown under traffic, it will be necessary to observe the performance and to obtain several sets of samples over a period of years from this experimental project.

3. The modified Deval test and possibly the wet shot rattler test appears to furnish a means for estimating the amount of breakdown in screenings that can be expected to occur when the screenings are rolled into place with a steel tired roller.

4. Any method developed to pre-determine the amount of oil and screenings to be placed on a road surface must include a factor allowing for the degradation of screenings under the roller. It is possible that such a factor can be developed from the modified wetting and drying test or from the standard wet shot rattler test.

5. There is need for a rapid, accurate method of measuring the uniformity of spread of the screenings and oil used in seal coat work.

TABLE I

Sample No.	Manufacturer	Source	GRADING ANALYSIS & PASSING											
			1/2	3/8	3/4	4	8	16	30	50	100	200	Wash	
54434	S. P. Milling	Stockpile	100	98	57	26	4	2	2	1	1	1	1	
54446	S. P. Milling	Sta 45+00	100	99	63	29	4	2	1	1	1	1	1	
54445	S. P. Milling	Sta 33+50	100	98	60	29	5	3	2	1	1	1	1	
54435	Granite Rock	Stockpile	100	96	51	28	7	2	1	1	1	1	1	
54443	Granite Rock	Sta 32+00	100	98	59	31	8	2	1	1	1			
54444	Granite Rock	Sta 18+00	100	95	48	23	6	2	1	1	1			
54433	W. Roselip	Stockpile	100	97	46	11	1	1						
54442	W. Roselip	Sta 9+50	100	98	50	11	1							
54441	W. Roselip	Sta 1+50	100	98	46	11	1	1						

TABLE II

Sample: No.	Source	#/s.v. Screenings : g. oil/s.v.		Grading Analysis & Passing											
		Applied	Recovered	Applied	1/2:3/8	3/8:1/2	1/2:3/4	3/4:1	1:1 1/2	1 1/2:2	2:2 1/2	2 1/2:3	3:3 1/2	3 1/2:4	4:4 1/2
54434	Stockpile				100	98	57	26	4	2	1	1	1	1	1
54362	Spread #1 Sta 48+25	17	16	.20	100	98	73	42	20	13	9	6	4	2	2
54366	Spread #2 Sta 39+85	22	15	.18	100	98	71	44	22	15	12	7	5	3	2
54360	Spread #10 Sta 31+56	22	11	.13	100	99	77	50	28	19	14	10	6	4	3
54368	Spread #11 Sta 39+80	20	13	.16	100	99	75	44	22	15	11	7	4	2	2
54363	Spread #12 Sta 49+25	20	11	.14	100	99	83	50	24	15	11	7	4	2	1
54435	Stockpile				100	96	51	28	7	2	1	1	1	1	1
54361	Spread #3	24	a. - 17	.13	100	97	74	51	30	19	14	11	7	5	3
54364	Sta 31+56	24	b. - 15	.13	100	98	79	56	33	20	14	10	7	6	5
54370	Spread #4 Sta 25+15	35	18	.15	100	98	75	52	30	18	13	9	6	4	3
54365	Spread #9 Sta 24+00	19	17	.13	100	99	67	44	24	15	10	7	5	3	2
54433	Stockpile				100	97	46	11	1	1					
54371	Spread #5 Sta 8+65	24	16	.15	100	98	72	39	22	16	12	7	5	3	3
54372	Spread #6 Sta 4+65	28	15	.19	100	98	78	47	28	19	14	10	7	5	4
54369	Spread #7 Sta 4+47	24	14	.12	100	98	71	40	22	15	11	7	5	3	3
54367	Spread #8 Sta 8+95	25	14	.13	100	98	72	42	23	15	11	8	5	3	2

a. - sampled 1 foot from shoulder.

b. - sampled 1 foot from center line.

FIG. I

EXPERIMENTAL SEAL COAT PROJECT  
FOR COMPARISON OF SCREENINGS FROM COMMERCIAL PLANTS

V-S-B-2-M, W.O. 95K4  
Placed 8-19-47 and 8-20-47

Los Alamos 1 Mi. Santa Maria 16 Mi.

S.P. Milling Co. (Gates)			Granite Rock Co.			W. Roselip Co.			Oil g/s.y.	Spread No.	Rock #/s.y.	Oil g/s.y.	Spread No.	Rock #/s.y.	Job Station Painted on East Shoulder	Survey Stations Shown on Bridge and Culvert Markers											
52+50	51+95	50+00	48+47	46+45	44+30	41+25	40+30	36+65	34+25	32+90	30+00	29+35	27+19	25+31	24+16	20+50	18+66	17+00	16+25	12+58	10+20	9+70	7+00	3+00	0+00	End of Project 143+13	
24#	24#	20#	20#	19#	20#	20#	20#	20#	20#	34#	22#	13g	21#	19#	13g	24#	18#	24#	24#	23#	15g	29#	24#	24#	28#	27#	
			(12)			(11)					(10)			(9)							(5)			(6)			
			.14g			.16g				.18g		.13g	.13g	.13g	.13g	.15g	.18g	.15g	.15g	.15g	.15g	.15g	.15g	.19g	.12g		
			(1)			(2)				(3)		(4)															
35#	17#	37#	29#	22#	38#	24#	45#	36#	35#	24#	18#	23#	29#	24#	28#	27#	24#	24#	24#	24#	24#	24#	24#	24#	24#	24#	

Note: Numbers in parentheses indicate the order in which oil spreads were placed.

Intended Applications:

S.P. Milling Co.	Screenings #/s.y.	Oil g/s.y.
Granite Rock Co.	22	15-17
W. Roselip Co.	25	15-17
	22	15-17

Beginning of Project 88+91

North End of Bridge across San Antonio Cr.

Beginning of Project  
North End of Bridge  
across San Antonio Cr.

Note: Numbers in parentheses indicate the order in which oil spreads were placed.

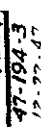
Intended Applications:

Screenings #/s.y.	Oil g/s.y.
22	15-17
25	15-17
22	15-17

S.P. Milling Co.  
Granite Rock Co.  
W. Roselip Co.



## SEMI-LOG CHART FOR GRADING CURVES





STATE OF CALIFORNIA  
DEPARTMENT OF PUBLIC WORKS •• DIVISION OF HIGHWAYS  
MATERIALS AND RESEARCH DEPARTMENT

SEMI-LOG CHART FOR GRADING CURVES

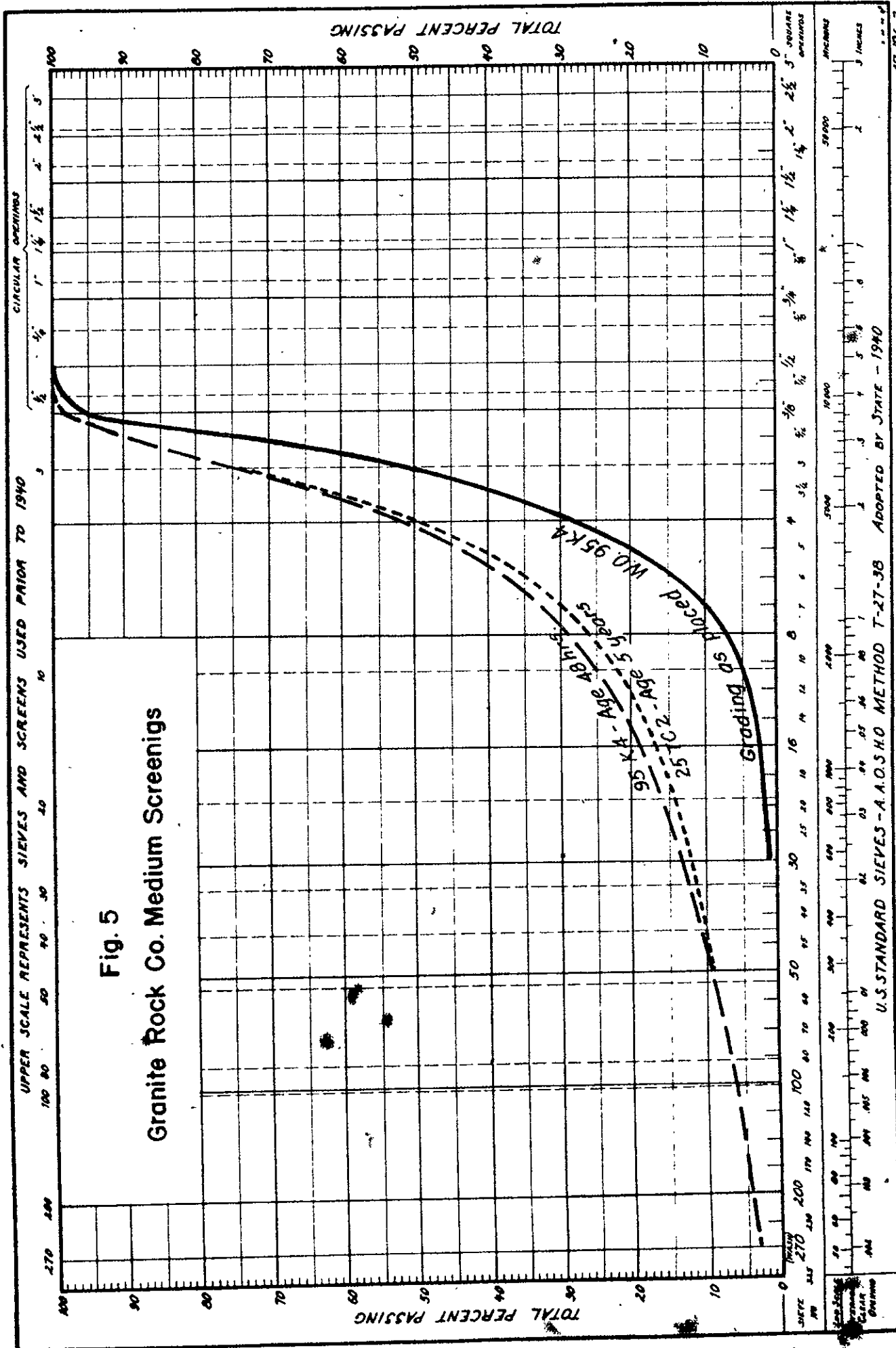
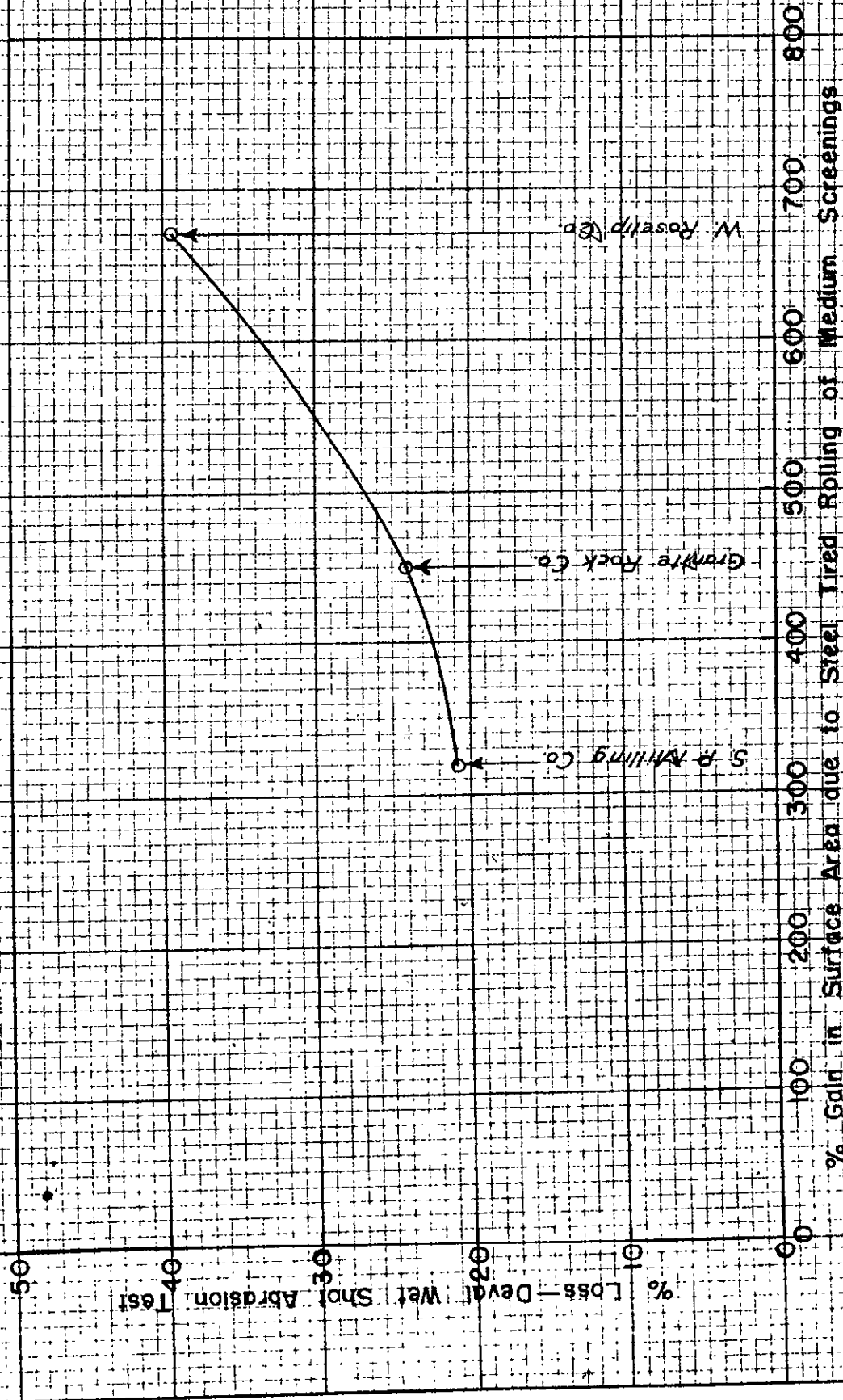


Fig. 6

RELATION OF DEVAL WET SHOT ABRASION TEST  
TO THE DEGRADATION OF MEDIUM SCREENINGS ON ROAD



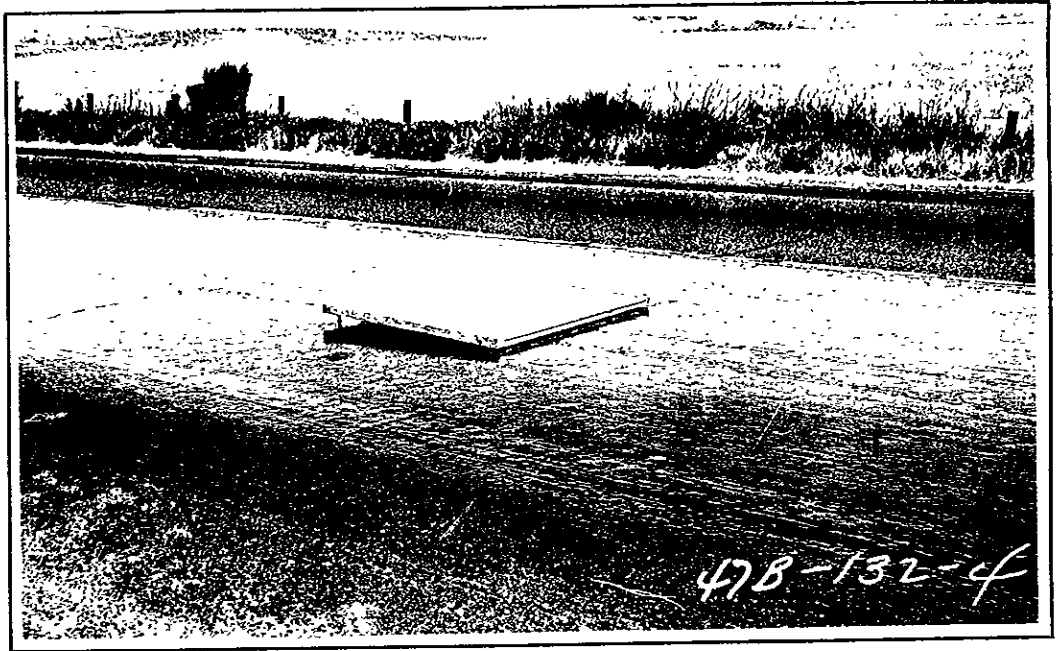


Fig. 7

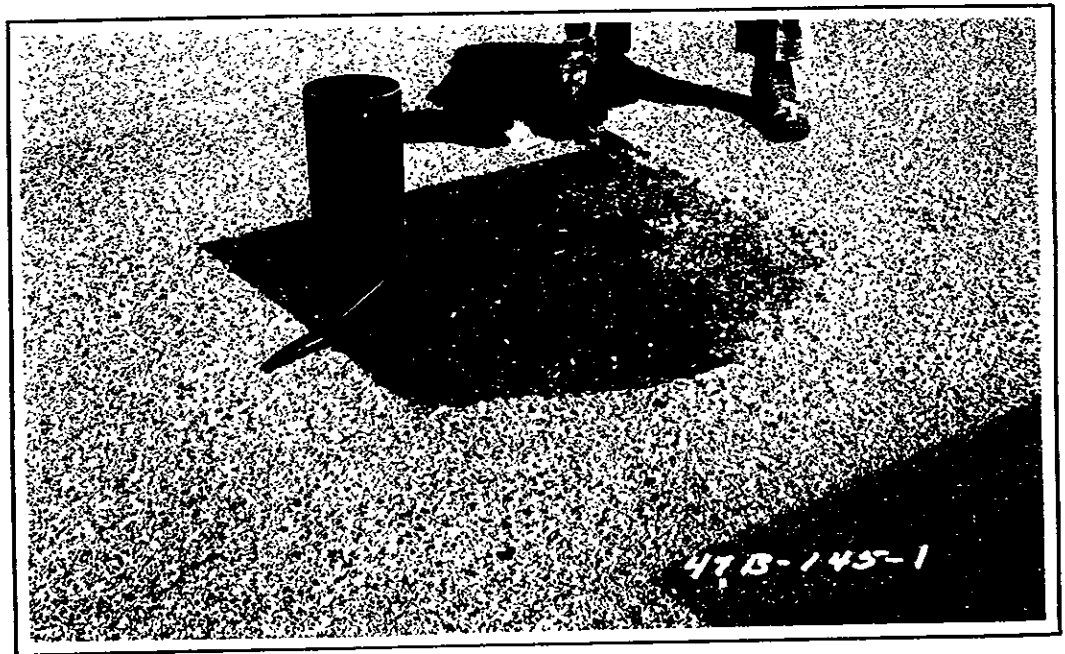


Fig. 8